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Science, technology and innovation for the post-2015 development agenda

Report of the Secretary-General

Executive summary

This report provides an overview of how science, technology and innovation (STI) can address key challenges for the post-2015 development agenda. It addresses one of the priority themes identified by the sixteenth session of the Commission on Science and Technology for Development (CSTD): Science, technology and innovation for the post-2015 development agenda, with two subthemes: (i) Taking stock: A decade of contributions of the Commission on Science and Technology for Development to the Millennium Development Goals; (ii) Looking forward: Science, technology and innovation prospects for the post-2015 development agenda. In doing so, the report highlights the work of the CSTD during the past decade towards achieving the Millennium Development Goals (MDGs) and provides a forward-looking insight into the next set of developmental challenges and policy implications surrounding STI applications beyond 2015.

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Introduction

1. At the end of the second millennium, the international community established a set of ambitious goals to be reached by the year 2015. As that year approaches, and as the development community assesses and learns from what has and has not been accomplished under the MDGs, the issue of new goals for the post-2015 period arises.

2. The CSTD at its sixteenth session held in June 2013 selected the following as one of its priority themes for 2013–2014: Science, technology and innovation for the post-2015 development agenda, with two subthemes: (i) Taking stock: A decade of contributions of the Commission on Science and Technology for Development to the Millennium Development Goals; (ii) Looking forward: Science, technology and innovation prospects for the post-2015 development agenda.

3. To contribute to a better understanding of this priority theme and to assist the Commission in its deliberations at its seventeenth session, the CSTD secretariat convened a panel meeting in Washington, D.C., from 2 to 4 December 2013. This report is based on the findings of the panel, national briefings contributed by CSTD members and other relevant literature. The report is presented in four chapters. Chapter I examines the important role of STI for development. Chapter II summarizes the decade of work conducted by the CSTD on various themes in relation to STI and demonstrates how its work is closely linked to MDGs. Chapter III looks ahead to articulate the role of the CSTD in the post-2015 development agenda and chapter IV highlights key findings and suggestions.

I. The important role of science, technology and innovation for development

A. Poverty, inequality and the road towards sustainable development

4. There has been a growing recognition that technology and innovation have a role to play beyond industrial growth. They are important to eradicate poverty, create jobs and promote the achievement of several MDGs. Our work shows indeed that the role of technology and innovation is positive and critical at each and every stage of development. Acknowledgement of this growing role begs the question of how countries can harness the strong linkages between technology and innovation policies for overall sustainable development and welfare. This issue is a pressing concern for all countries.

5. The first challenge where STI has a critical role to play is multidimensional poverty. In addition to income, various factors comprise the deprivation experienced by the poor, including lack of education, health, housing, empowerment, employment, personal security and more. STI has a huge potential to contribute to tackling these multiple dimensions of poverty through a variety of channels. For instance, STI facilitates the creation of jobs, enhances delivery of basic public services, improves access to knowledge and education, and empowers the marginalized sections of society. However, there is need to ensure that STI efforts are directed through these channels, so that the people who are most in need are empowered in the process.

6. Inequality, the second challenge, is an indicator of whether development is inclusive.[1] During 2006–2011, income inequality has increased within most countries

[1] A Sen, 1992, *Inequality Reexamined* (Cambridge, Massachusetts, Harvard University Press).

around the world[2] and over the last two decades (1990–2010) income inequality increased by 11 per cent in developing countries.[3] To meet development challenges, policymakers need to pay attention to both horizontal and vertical inequalities.[4] Vertical inequalities are the distances between rich and poor, while horizontal inequalities are the distances between advantaged and disadvantaged culturally defined groups, such as genders, races, and religious groups.

7. Unequal distribution of income is one dimension of inequality. Differences in access to resources such as education, sanitation, water, electricity, housing, nutrition and healthcare also represent inequality, and contribute to the sense of exclusion and disempowerment. Decreasing income inequality therefore only partially addresses inclusive development. A holistic process of inclusive development would involve leadership from people in previously marginalized communities, finding ways to use their skills to earn a living, acquiring new capabilities, and contributing to economic growth. In a highly unequal society, STI is often an elite activity, serving a few people and industries. In inclusive development, STI is no longer restricted to laboratories and frontier technologies, but contributes to solving day to day challenges.[5]

8. A third challenge is making development sustainable. The primary needs of a large number of people worldwide remain largely unmet, or often met through unsustainable means. Energy systems must be transformed on a global basis to spread the advantages of electricity without excessive greenhouse gas emissions. Science and engineering have a central role to play in that redesign. Similarly, 783 million people do not have access to clean water and almost 2.5 billion do not have access to adequate sanitation.[6] These problems constitute some of the main global challenges that engineers have identified for their profession.[7]

9. The way these three challenges are addressed will be quite different in various national contexts, but in all cases they are linked to innovation processes, with critical contributions from science and technology. Targeted efforts to bring technical and local knowledge together, however, can lay the groundwork for inclusive and sustainable development, which must rest on a base of increasing educational attainment for the whole population.

B. Linking science, technology and innovation capabilities to the fundamental challenges of development

10. To understand the connections between STI, poverty, and inclusive and sustainable development, the results of STI must be understood not just as technologies but as

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[2] A Hodgson, 2012, Special report: Income inequality rising across the globe, Euromonitor International, 12 March, available at http://blog.euromonitor.com/2012/03/special-report-income-inequality-rising-across-the-globe.html, accessed 21 February 2014.

[3] United Nations Development Programme, 2014, *Humanity Divided: Confronting Inequality in Developing Countries* (New York).

[4] F Stewart, 2002, Horizontal inequalities: A neglected dimension of development, Queen Elizabeth House working paper series, University of Oxford, available at http://www3.qeh.ox.ac.uk/pdf/qehwp/qehwps81.pdf.

[5] http://www.undp.org/content/undp/en/home/ourwork/povertyreduction/focus_areas/focus_inclusive_development.html, accessed 26 February 2014.

[6] http://www.unwater.org/water-cooperation-2013/water-cooperation/facts-and-figures/en/, accessed 21 February 2014.

[7] http://www.engineeringchallenges.org/cms/8996/9142.aspx, accessed 26 February 2014.

sociotechnical systems.[8] In such a sociotechnical system, humans and technologies work together to produce outcomes to effectively respond to societal challenges.[9] For example, a transportation system is not just vehicles and roadways, but also how people drive and ride, and build and carry out maintenance. A drug designed to save lives, such as insulin, can actually kill if it is not used according to instructions, such as timing, control of dosage and equipment disposal, all of which require a certain level of education and preparation in a sociotechnical system

11. There is broad consensus that a well-functioning national STI ecosystem needs to include, inter alia, political stability and well-functioning institutions, an educated workforce, sound research and education infrastructure, linkages between public and private innovation actors, enterprises committed to research and development, and a balanced intellectual property rights framework. However, this by itself is insufficient to ensure STI for inclusive and sustainable development.

12. Applying STI to inclusive and sustainable development involves three related approaches:

(a) Addressing basic needs through innovation capacity;

(b) Promoting entrepreneurship, starting at the grassroots level;

(c) Promoting inclusive growth by building STI capabilities and absorptive capacities.

13. First, developing innovation capacity in the sociotechnical systems that meet the basic needs of people, such as food, water, sanitation, health, housing and transportation promotes the ability of countries to deliver essential public goods. All these needs have technological elements and may require complex combinations of household, community, public and private action. Local problems often act as a major stimulus to innovation, and these need to be fostered through policy incentives. Examples abound, including the cure to sickle cell anaemia in Nigeria by local researchers, or the discovery of new irrigation technologies in Asia.

14. Second, in addition to its role in providing global public goods, STI serves as a crucial driver of rising prosperity and improved national competitiveness. Promoting entrepreneurship, including grassroots entrepreneurship, is a critical engine of improving living conditions and growing incomes. Entrepreneurship is often disconnected from innovation policies, and the relevance of grassroots entrepreneurship is largely underestimated.

15. Third, building STI capabilities over time is an important prerequisite of promoting inclusive growth, but inclusiveness is not automatic. Studies on economic catch-up of several countries illustrate this clearly:[10] a strong, government-led effort that allows sociotechnical systems to flourish, local firms to be formed, survive, grow, and provide jobs is essential for inclusive catch-up, as the case of the Republic of Korea illustrates.

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[8] M Fressoli, A Smith and H Thomas, 2011, From appropriate to social technologies: Some enduring dilemmas in grassroots innovation movements for socially just futures, ninth Globelics International Conference 2011, 15–17 November, Buenos Aires.

[9] WE Bijker, TP Hughes and T Pinch, eds., 1987, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, Massachusetts, MIT Press).

[10] L Kim, 1997, *Imitation to Innovation: The Dynamics of Korea's Technological Learning* (Boston, Harvard Business School Press).

II. Taking stock: A decade of work on science, technology and innovation issues by the Commission on Science and Technology for Development towards the realization of the Millennium Development Goal targets

16. Through its priority themes, the CSTD has worked on a range of STI issues that are relevant for development over the past decade and that can be grouped under five significant thematic areas. These are:

(a) STI and bridging the technological divide;

(b) STI to meet social objectives, such as sustainable urbanization, agriculture and energy;

(c) STI for capacity-building, particularly through education and research;

(d) Information and communications technologies (ICTs) and the digital divide;

(e) The impact of new technologies on development.

The priority themes under these five thematic areas contribute to various MDGs and the associated debates on how to promote the effectiveness of various interventions in the developmental process (see table).

Linking the science and technology priority themes of the Commission on Science and Technology for Development with the Millennium Development Goal targets

Priority themes	*Millennium Development Goals*
1. STI for sustainable cities and peri-urban communities	Goal 1: Eradicate extreme poverty and hunger
	Goal 7: Ensure environmental sustainability
2. Open access, virtual science libraries, geospatial analysis and other complementary ICT, STI, engineering and mathematics assets to address development issues, with particular attention to education	Goal 1: Eradicate extreme poverty and hunger
	Goal 2: Achieve universal primary education
	Goal 4: Reduce child mortality
	Goal 5: Improve maternal health
	Goal 6: Combat HIV/AIDS, malaria and other diseases
	Goal 7: Ensure environmental sustainability
3. Measuring the impact of ICTs for development	Can potentially be linked to all Goals since ICTs are critical for delivering STI applications to address challenges, including target 7.D and indicator 7.10
4. Innovation, research and technology transfer for mutual advantage,	Can potentially be linked to all Goals since building innovation capabilities are critical

entrepreneurship and collaborative development in the information society	to promote problem-solving, including addressing Goal 4 (reduce child mortality rate, particularly indicator 4.3 in relation to immunization against measles); Goal 6 (combat HIV/AIDS, malaria and other diseases); Goal 7 (ensure environmental sustainability, particularly targets 7.B, 7.C and 7.D)
5. Technology and innovation for sustainable agriculture	Goal 1: Eradicate extreme poverty and hunger Goal 3: Promote gender equality and empower women Goal 7: Ensure environmental sustainability
6. New and emerging renewable energy technologies for sustainable development	Goal 1: Eradicate extreme poverty and hunger Goal 7: Ensure environmental sustainability
7. STI and engineering and capacity-building in education and research	Goal 1: Eradicate extreme poverty and hunger Goal 2: Achieve universal primary education Goal 7: Ensure environmental sustainability
8. Promoting the building of a people-centred, development-oriented and inclusive information society, with a view to enhancing digital opportunities for all people	Goal 2: Achieve universal primary education Goal 3: Promote gender equality and empower women
9. Bridging the technological gap between and within nations	Goal 1: Eradicate extreme poverty and hunger Goal 2: Achieve universal primary education Goal 7: Ensure environmental sustainability
10. The mutual interaction and dependency of science and technology education with research and development	Goal 1: Eradicate extreme poverty and hunger Goal 2: Achieve universal primary education Goal 7: Ensure environmental sustainability

Source: Compiled by the CSTD secretariat.

A. Science, technology and innovation for the Millennium Development Goals and bridging the technological divide

17. The CSTD was one of the first forums to discuss the growing technological divide and how to promote STI to meet the MDGs. In 2004, discussions focused on "Promoting the application of science and technology to meet the development goals contained in the Millennium Declaration".[11] The following key issues were highlighted, particularly focusing on new and emerging technologies:

(a) Biotechnology can provide effective solutions for eradicating extreme poverty and hunger[12] through increased crop yields, as well as reducing child mortality[13] and improving maternal health[14] through enhancing nutritional value in foods. However, it also poses potential risks which could be counterproductive to ensuring environmental sustainability,[15] and human health.

(b) ICTs promote distance training of teachers and health workers, which aids the achievement of universal primary education.[16] It can also assist in the reduction of child mortality, improvements in maternal health and combating HIV/AIDS, malaria and other diseases.[17].

(c) Technology is not just difficult to diffuse across national borders, but also within. National income inequality amplifies the gap between the rich and the poor in terms of access and affordability of various STI services, including ICTs, resulting in a significant digital divide.[18]

18. Policy recommendations of the CSTD on this theme include the following:

(a) A need for human capital development, for an improvement of physical and services infrastructures, and for global efforts, such as international technology transfers and internationally coordinated projects;

(b) Governments should build local capabilities to target and facilitate acquisition of technology through foreign direct investment, particularly by focusing on the acquisition of information and knowledge, in addition to imports of machinery and equipment, which are by-products of international trade.

B. Science, technology and innovation to meet social objectives, such as sustainable urbanization, agriculture, and energy

19. Keen to analyse and consider STI as a means to achieve social objectives, the Commission has considered three such social objectives at length over the past decade: energy, sustainable agriculture and sustainable urbanization.

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[11] See http://unctad.org/en/Docs/ecn162004d2_en.pdf, accessed 26 February 2014.
[12] Goal 1: Eradicate extreme poverty and hunger.
[13] Goal 4: Reduce child mortality.
[14] Goal 5: Improve maternal health.
[15] Goal 7: Ensure environmental sustainability.
[16] Goal 2: Achieve universal primary education.
[17] Goal 6: Combat HIV/AIDS, malaria and other diseases.
[18] See http://unctad.org/en/Docs/ecn162006d2_en.pdf, accessed 26 February 2014.

1. New and emerging renewable energy technologies for sustainable development[19]

20. To enable diffusion and development of renewable energy technologies, the Commission identified key issues and policy considerations, including the following:

(a) The importance of access to electricity and modern energy services to, inter alia, enable higher yields in agricultural production, which can tackle extreme poverty and hunger; increase access to information and telecommunications; improve health and quality of healthcare; improve the general standard of living;

(b) The role played by access to modern energy in gender equality and education.[20]

21. Policy recommendations made by the CSTD include:

(a) On the technical front, international organizations should continue to provide support through technical assistance in training, capacity-building and strategic planning to promote new and renewable energy sources and technologies.

(b) On the financial front, large-scale resources have been committed by various international agencies to accelerate investments in technological changes, but these need to be mobilized.

(c) On the political front, it is necessary to address the unresolved issue of how to balance trade and intellectual property regimes for technology transfer, processes and production methods (for example, open-source software, Eco-Patent Commons and global technology patent pools).

2. The role of technology and innovation in sustainable agriculture[21]

22. To suggest appropriate forms of policy support, the CSTD highlighted the importance of new as well as traditional sustainable production methods and related skills and technologies of relevance for the promotion of sustainable agriculture. Key issues include the following:

(a) How can promising science and technology applications and farming practices be applied globally to increase agricultural productivity?

(b) How can agricultural innovation systems, which involve the integration of different sources of knowledge, including local knowledge, be promoted? For example, women and other marginalized groups often hold local knowledge of high-impact, low-cost methods and coping strategies that can make farming systems more resilient.

(c) How to design intellectual property rights regimes that protect farmers and expand participatory plant breeding, while fostering local control over genetic resources and related traditional knowledge to increase equity?

23. Policy considerations made by the CSTD include the following:

(a) National innovation coalitions and innovation platforms around particular technologies, policies, or processes are critical for innovation.

(b) Successful agricultural innovation requires attention to all components of agricultural systems including research, extension, credit and technical support, healthy markets, functioning infrastructure, and a supportive policy and institutional environment.

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[19] See http://unctad.org/en/Docs/ecn162010d4_en.pdf, accessed 26 February 2014.

[20] Goals 2 and 3.

[21] See http://unctad.org/en/Docs/ecn162011d2_en.pdf, accessed 26 February 2014.

(c) Harnessing the potential of intellectual property rights for the protection of farmers and the promotion of plant breeders is essential. This may also enable local control of genetic resources related to traditional knowledge, which can increase equity.

3. Science, technology and innovation for sustainable urbanization[22]

24. The Commission focused on innovative planning, technology and governance models already in use in several cities across the globe. Improvements in spatial planning and mobility can play a role in poverty eradication. Energy, waste management and buildings are sectors that can address resource depletion.[23] Increased resilience in cities is a cornerstone of adaptation to climate change. Integrating peri-urban zones into urban planning can bring benefits in terms of food security, water and employment opportunities.[24]

25. The key issues considered included the following:

(a) Addressing inadequate transportation infrastructure in cities through technologies that improve urban mobility;

(b) Innovative energy solutions that work best in crowded urban environments, such as kinetic energy-generating pavements, district heating systems, and smart electric grids;

(c) The use of integrated waste management to address urban waste, as well as waste-collection initiatives through partnerships with various actors;

(d) The role of hazard monitoring and surveillance techniques, geospatial tools for assessing disaster risk, as well as ICTs to enable cities to monitor risks in an integrated manner and contribute to natural disaster resilience.

26. A rich set of policy recommendations made by the CSTD focused on the use of low-tech and high-tech solutions to promote sustainable urban growth, such as the following:

(a) Developing spatial plans in early phases of urbanization based on political consensus of stakeholders can be beneficial.

(b) Cities can make use of technologies to convert certain types of waste into energy.

(c) The use of new technologies in cities can reduce the burden of rapidly increasing energy demand.

(d) Local governments in developing countries can address housing shortages through construction initiatives for affordable, sustainable housing and upgrading informal settlements.

(e) Peri-urban areas can benefit from social inclusion programmes that upgrade existing informal settlements and prevent the formation of new informal settlements through adequate spatial planning.

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[22] See http://unctad.org/meetings/en/SessionalDocuments/ecn162013d2_en.pdf, accessed 26 February 2014.

[23] This contributes to all targets of Goal 7.

[24] This contributes to Goals 1 and 7.

C. Science, technology and innovation, and capacity-building, particularly through education and research

27. Following the 2008 United Nations MDGs report, which indicated that indigenous technological capabilities have not yet played a very significant role, the CSTD highlighted some of the progress made in a number of MDG areas through STI, and deliberated upon issues that need further attention.[25] These include the decrease in mortality rates[26] caused by diseases such as malaria, HIV/AIDS and measles,[27] and an increase in the number of people with access to safe drinking water.[28] For some targets, as recognized by the CSTD, progress has depended upon large-scale internationally funded projects to distribute product-embedded technology directly to the user. These include, for example, the distribution of anti-retroviral, insecticide-treated bed nets, and measles vaccination programmes. An important reference was made to the time period required by many countries, especially in sub-Saharan Africa, for capacity-building in STI. In this respect, the CSTD noted that there is a need to plan beyond the 2015 MDG targets and discussed related issues as part of three main themes, as presented below.

1. Deployment of science and technology for development

28. Science and technology for development needs to begin with building indigenous capabilities and creation of absorptive capacity in countries, but is insufficient by itself to achieve technological catch-up in developing countries. Some key recommendations made under this topic were as follows:

(a) Building innovative capabilities at the national level requires efforts in three interrelated areas: enterprise development, human capital and STI policy capacity.

(b) From a national innovation system perspective, STI-related policies cross various sectoral/ministerial mandates. Building a successful innovation system will depend on creating a balance between both the prevailing national and global contexts, which are constantly changing.

(c) Prioritizing South–South cooperation in addition to existing North–South cooperation at the national level in STI policies is crucial to explore new partnerships for development.

2. Technology transfer for mutual advantage, entrepreneurship and collaborative development[29]

29. Collaborative learning is critical for information exchange processes that generate mutual advantage and entrepreneurship. It underlies collaborative development efforts that extend beyond the private sector to the education, health and environment sectors. Technologies can improve entrepreneurial opportunities, enhance the means of earning a livelihood and open opportunities for trade and development.[30] The CSTD explored opportunities for collaborative research and development and innovation as a basis for capacity-building, and found that:

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[25] See http://unctad.org/en/Docs/ecn162009d3_en.pdf, accessed 26 February 2014.
[26] Goal 4.
[27] Goal 6.
[28] Goal 7.
[29] See http://unctad.org/meetings/en/SessionalDocuments/ecn162012d2_en.pdf, accessed 26 February 2014.
[30] This contributes to Goal 1.

(a) Exploring new opportunities for technology transfer involving knowledge brokering and exchange between higher income and lower income countries are crucial;

(b) Developments in physical infrastructure have not been sufficient to deliver the benefits of the information society, particularly in low- and middle-income countries;

(c) Rapid evolution and variety of access arrangements and institutional forms that offer important opportunities for public policy and entrepreneurial involvement are needed.

3. The mutual interaction and dependence of science and technology education with research and development

30. The CSTD reflected on one of the most critical linkages in the innovation system, namely, the link between education and research and development. Educational institutions, especially those of higher learning, play a significant role in research and economic development. They provide the pool of indigenous researchers and technicians as well as the platform for conducting research and development. In addition, many universities in developing countries increasingly carry the responsibilities of improving regional or national economic performance. The following key issues were considered:

(a) How can scientists apply their knowledge and influence in other fields of specialization to address global challenges, including the MDGs, and to influence policymaking?

(b) How best to review academic reward systems, particularly within developing countries, to elevate the stature of working in science and technology for development?

31. The policy recommendations included:

(a) Building absorptive capabilities within enterprises and social-welfare-provider organizations needs to be a major goal for STI policy, as these capabilities are necessary for innovation within countries;

(b) The following shortcomings, which compound at the policy level the difficulties in balancing short-term priorities and long-term goals, need to be addressed:

(i) A lack of empirical analysis of the time needed for the process of "learning" (in organizations, and at the national level);

(ii) A lack of appropriate policy research and analysis methods to evaluate the systemic impacts of different policy options;

(c) The establishment needs to be encouraged of technology offices, technology parks and incubators, which have proven to be effective to pool the scarce resources to stimulate research commercialization and subsequent enterprise growth.

D. Information and communications technologies and the digital divide

32. The CSTD has deliberated at length upon issues relating to ICTs and development. In the past decade, the scope of ICT applications has gradually increased, covering a wide spectrum of areas including health, education, employment creation, and sustainable management of resources. Some applications are critical to promote basic needs, such as health, but many applications rely on promoting economic well-being and development at a broader level. The CSTD has highlighted the prerequisites, such as ICT literacy, that are necessary to reap the benefits of ICTs, the lack of which amplifies developmental gaps among countries.

33. The CSTD has also highlighted new challenges brought about by ICTs. First among these is the digital divide, which results in countries with poor ICT infrastructure missing out on their benefits. A second implication relates to the growing importance of ICTs for business and social-service delivery, which calls for reforms in existing institutional and regulatory frameworks. Coping with these impacts requires new, multi-stakeholder governance models and sectoral restructuring. Moreover, the rapid change in ICTs perpetuates the need for such industry restructuring, which has implications for developing countries in terms of policy, as they need support to establish the right institutional frameworks to benefit from ICTs. The last challenge brought about by ICTs is the need for the development community to recognize them as more than just infrastructure, but essential tools that enable inclusive social and economic development, as in the areas of e-health and e-education.

34. These issues were deliberated as part of several themes:

(a) Promoting the building of a people-centred, development-oriented and inclusive information society;[7]

(b) Development-oriented policies for a socioeconomically inclusive information society, including policies relating to access, infrastructure and an enabling environment;[8]

(c) Measuring the impact of ICTs for development.[9]

35. The CSTD also noted emerging positive and negative implications of the Internet. Amongst the negative impacts, it highlighted the need to promote discussions on ways to deal with Internet-based crime, including fraud and copyright infringement, child exposure to undesirable content and overuse of Internet applications and games; use of the Internet to disseminate pornographic contents; and security and privacy concerns. At the same time, the Commission lauded the positive environmental impacts of ICTs including their potential to improve energy efficiency; facilitation of dematerialization; climate change monitoring and modelling; dissemination of information; and administration of carbon-pollution reduction schemes. Negative impacts also arise from energy usage and greenhouse gas emissions due to use, manufacturing and transport of ICT products and pollution from e-waste disposal.

36. The CSTD also recommended that reaping the benefits of ICT development requires coherent national policies in developing countries that tackle existing institutional challenges and set out priorities for policy coordination, taking into account political, educational, cultural, scientific, legal and financial factors. An inclusive information society will depend on governmental intervention to correct market failures, maintain competition, attract domestic and foreign investment and enhance ICT infrastructure and applications to maximize the socioeconomic benefits of ICTs, especially for underserved communities.

37. These deliberations led to several policy recommendations in relation to enhancing digital opportunities for all, including:

(a) National capability in ICT research and development should be enhanced to achieve sustainable development of the information society.

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[7] Substantive theme selected by the CSTD for the intersessional period 2006–2008. See http://unctad.org/en/Docs/ecn162007d2_en.pdf, accessed 26 February 2014.

[8] Substantive theme selected by the CSTD for the intersessional period 2008–2009. See http://unctad.org/en/Docs/ecn162008d2_en.pdf, accessed 26 February 2014.

[9] Substantive theme selected by the CSTD for the intersessional period 2010–2011. See http://unctad.org/en/Docs/ecn162011d3_en.pdf, accessed 26 February 2014.

(b) Partnerships should be fostered between developing countries in research and development, technology transfer, manufacturing and utilization of ICT products and services, to promote capacity-building and global participation in the information society;

(c) There is an urgent need to strengthen institutions and policies in developing countries dealing with STI and in particular, ICTs.

E. The impact of new technologies on development

38. The CSTD considered the impact of newer technologies on development, emphasizing their benefits as well as cautioning about the risks of exclusion, particularly in relation to open access and geospatial technologies.[39]

39. Key issues considered by the CSTD included the role of ICTs in promoting open access and virtual science to overcome barriers to the building and dissemination of the global stock of knowledge, particularly in developing countries.[40] The CSTD concluded that geographic information systems (GIS) and geospatial analysis can enhance education: they offer novel ways to interpret the world, they can help us to do tasks more quickly, make complex problems more manageable, and use advanced methods of analysis.

40. To promote these social benefits, the CSTD recommended increasing the use of GIS in education to help develop the spatial abilities required in a range of different subjects beyond geography classes. There should be efforts to integrate GIS in policymaking more fully, building GIS capacity at all levels, supporting the development of GIS applications for education, and building networks of GIS practitioners to share knowledge and best practices.

III. Looking forward: science, technology and innovation and the post-2015 development agenda

41. The post-2015 development community has the daunting task of shaping a policy agenda for development that could be relevant for decades to come. Taking stock of the decade-long work in the CSTD on STI issues, as encapsulated under the five thematic areas, helps to articulate the role of STI policies for inclusive development[41] in a variety of important topics. While one can argue that the priority themes of the CSTD have not directly reviewed progress made under individual MDGs, the work of the CSTD has always focused on how each of the MDGs can be realized through STI. Current reviews show that lack of STI capacity has in fact hindered the attainment of several MDGs. While this underlines the critical role of STI for the accomplishment of the MDGs, it also posits valuable lessons for the post-2015 agenda. The CSTD themes and recommendations thereunder have focused on how STI policies can promote three essential, inter-related goals to contribute to inclusive and sustainable development:

(a) Promoting innovation capabilities to meet basic needs;

(b) Encouraging entrepreneurship;

(c) Fostering inclusive growth through building STI capabilities.

[39] See E/CN.16/2012/3, available at http://unctad.org/meetings/en/SessionalDocuments/ecn162012d3_en.pdf, accessed 27 February 2014.

[40] Contributes to Goal 2.

[41] See http://unctad.org/en/Docs/ecn162004d2_en.pdf, accessed 27 February 2014.

42. These results, therefore, are directly relevant to the discussions within the post-2015 development community on how STI policies can be used to achieve these three objectives. The previous MDGs exercise has struggled to find ways to embed cross-cutting themes, such as STI, that are relevant to all basic needs of humankind. It is precisely on this point that the CSTD can play a very relevant role: namely, helping to articulate the role of STI in the post-2015 agenda, particularly bearing in mind the developmental challenges of the future. A recent report of the United Nations National Intelligence Council characterizes the world today and provides possible global trajectories during the next 15 to 20 years.[37] Several key issues identified may have significant implications for the post-2015 development agenda. These issues can be summarized under two major trends with lasting global impact in the years leading up to 2030: individual empowerment, and disruptive technologies.[38] The expansion of the global middle class from 737 million in 1965 to an estimated 4.8 billion people by 2030 is expected to be largely accounted for by a shift of economic power to the East and South. This shift should be poverty reducing, leading to rising demands for sociopolitical change and individual empowerment.

43. At the same time, the second major trend forecasted is that of wider access to the so-called "lethal and disruptive technologies", which will result in a persisting sense of insecurity on the one hand, and rapid growth caused by widespread exploitation of new enabling technologies, particularly in developing countries. Rapid growth in ICT-driven innovation will increasingly result in the convergence of technologies, leading to innovation in areas such as human augmentation, the Internet of things, interconnected markets and machine communication.[39]

44. Such breakthroughs will result in technologies taking over routine tasks from humans and revolutionize individual abilities to affect societies. Hence, disruptive technologies will require adaptation in terms of employment creation in new areas and government regulation to manage possible negative impacts, without hampering the opportunities. Ways and means to address these issues in a sustainable manner will undoubtedly involve the application of science and technology.

45. The CSTD needs to bear upon the post-2015 agenda as the torchbearer of the United Nations system for STI issues, by becoming a forum for horizon scanning on future developmental challenges that STI can resolve, and by presenting venues for strategic planning and policy making on the role of STI in shaping developmental outcomes.

A. Framing science, technology and innovation as a core issue for sustainable development

46. The CSTD, as a forum where countries and experts share best practices in policy and practice, can promote a more unified treatment of STI frameworks within national contexts to promote the linkages between STI and inclusive and sustainable development. Traditionally, components of STI policies have mainly been seen as falling into four major categories:

(a) Human resource policies;

(b) Research policies;

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[37] National Intelligence Council, 2012, *Global Trends 2030: Alternative Worlds*, ISBN 978-1-929667-21-5 (Washington, D.C.), available at http://www.dni.gov/files/documents/GlobalTrends_2030.pdf.

[38] Ibid.

[39] Ibid.

(c) Technology and innovation policies;

(d) Regulatory policies.

47. Human resource policies have aimed at ensuring an adequate supply of appropriately trained people for STI activities. Similarly, science policies have focused on supplying scientists and engineers and setting up science councils. Knowledge advancement has traditionally been concentrated in academy-type systems, and issues of creating collaborative networks for product and process development, knowledge flows and interactive learning have been neglected, which are fundamental to channelling scientific capacity into problem solving and fostering locally adapted innovations that cater to local needs.

48. Regulatory policies set the ground rules for technological use. While some are directed to new technologies (such as drug safety regulations), others are heavily science based (such as environmental regulation of industrial chemicals).

49. The past decade has seen a significant movement from technology policies to technology and innovation policies in the developing world. However, there are narrow and broad definitions of the innovation process, and innovation policies may reflect one, the other, or both. The narrow definition is enshrined in STI indicators and relates to formal research and development processes. It focuses on product, process and service innovations, measured through surveys and patents.[40] The broader definition sees innovation as a process that permeates society.[41] It encompasses process, product and organizational improvements as innovations whether or not these are technological, so long as they give business a competitive advantage.

50. Each of these domains has operated fairly independently at the national levels, despite the relevance of jointly creating STI capabilities that foster developmental outcomes. The CSTD, as the forerunning forum for discussions on STI and development, should discuss and promote ways in which each of these policies can be more closely integrated with inclusive development. STI solutions to promote active responses to the trends that will characterize the world at 2030 and beyond will depend on an approach where these policies are coordinated more closely together with clear policy incentives and milestones. Some of the ways and means are proposed in the following sections.

1. Human resource policies – ensuring sufficient numbers of scientists and engineers for a nation's needs

51. Research councils, which are the central agencies ensuring human resources for STI, need to engage in public outreach to attract students to science and engineering careers. The councils often offer fellowship support for domestic postgraduate study in science, technology, engineering and mathematics. Such fellowship support may be oriented to strategic research areas that are seen as important for national industrial or social development. Research councils also need to work closely with national education authorities in expanding education capacity, particularly for tertiary education and vocational training.

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[40] See http://www.oecd.org/innovation/inno/frascatimanualproposedstandard practiceforsurveysonresearchandexperimentaldevelopment6thedition.htm, accessed 27 February, 2014.

[41] BA Lundvall, 1988, Innovation as an interactive process: From user-producern interactions to national systems of innovation. In: *Technical Change and Economic Theory*, G Dosi et al., eds. (London, Pinter) and RR Nelson, 1993, *National Innovation Systems: A Comparative Analysis* (New York, Oxford University Press).

52. Establishing programmes to send students overseas for advanced training, with the goal of building local capacity, has been helpful in several countries. However, such programmes face the challenge of brain drain, which can be addressed through legal requirements for accepting the fellowship. Such incentives are particularly needed in least developed countries, as the figures on brain drain from Africa demonstrate.[42]

53. Research council registries of scientists and engineers with competitive grants to support curiosity-driven research have shown good results in many countries. Such grants can be used not only to build and maintain a competitive human resource base, but also to encourage collaborative projects that promote local needs-based innovation, which can even be a requirement of grants schemes. The Council for Scientific Research at the University of the Republic in Uruguay, for example, has pioneered the design of programmes that link university researchers effectively with local communities to solve problems.[43]

54. Research councils, or their partners in Government, sometimes find resources for larger research centres oriented towards industries that are relevant for local priorities of countries. Because research centres combine educational with research and outreach functions, they represent opportunities for directing the scientific culture towards inclusive and sustainable goals. Outreach can involve community innovation and support for small business development. Sustainability can be a required theme for every centre and can be built into the core of any large research effort.

2. Research policies – advancing fundamental and strategic knowledge

55. Several influences compete for attention on the research agendas of developing countries:

(a) The competitiveness agenda calls for research to be oriented to the needs of industry. This orientation may direct attention to the needs of larger, export-oriented firms rather than small farmers, as for example in research on bananas in Jamaica or coffee in Costa Rica.

(b) The international profile agenda urges researchers to publish in international journals, and for firms to survive in an international environment, with the implicit result that topics of interest outside the country may become a focus of industry and science. The pharmaceutical sector in many developing countries is a good example of this. This orientation tends to tilt research and innovation away from nationally or locally important issues.

(c) The development agenda places priority on the knowledge base for addressing issues that are impeding development, particularly basic needs areas such as health, food, energy and water.

56. Integrating developmental concerns and local priorities into innovation agendas requires the strengthening of public-sector institutions in developing countries. These are often the backbone not only for research, but also for innovation. British Commonwealth countries often have public research institutions named "Council for Scientific and Industrial Research," or a variation thereof. As their names imply, their main clientele has

[42] See http://www.universityworldnews.com/article.php?story=20131011121316706 and http://www.idrc.ca/EN/Resources/Publications/Pages/ArticleDetails.aspx?PublicationID=704, accessed 27 February 2014.

[43] S Alzugaray, L Mederos and J Sutz, forthcoming, Building bridges: Social inclusion problems as research and innovation issues, *Review of Policy Research*.

traditionally been industry. Other developing countries follow the model of "academies" that are not honorific but rather sets of public research institutions.

57. Most developing countries have public-sector institutions, but their ability to be directly responsible to public goals and to act as potential sites for implementing inclusive and sustainable research agendas needs to be fostered. The post-2015 development agenda research, therefore, could be embedded into the strategic plans and operational directions first and foremost of public research institutions. Specialized bodies such as the Institute for Water Technology in Mexico could then become more common.

3. Innovation policies – stimulating the development of new products and processes

58. Most conventional innovation policies, such as intellectual property laws, technology-transfer programmes, and tax incentives for research and development are designed with the narrow definition of innovation in mind, neglecting broader societal benefits of new ideas and businesses, as well as employment generation for all. The pathway to inclusive and sustainable development, however, requires a different set of innovation policies, including extension and public technology development, as well as incentives and support for entrepreneurship.

59. Innovation to reach low-income markets is also known as "bottom of the pyramid". Large multinational firms have a substantial opportunity to serve that market, if they are innovative enough to repackage or redesign their products appropriately.[44] Unfortunately, examples of such successes are few.

60. Where innovators are linked to top-down technology systems such as public utilities, knowledge from the bottom may not be valued. Where small innovators are part of their own local networks, however, lateral learning may occur so quickly that innovation scarcely gives an advantage. This pattern is reported in the *jua kali* sector in Tanzania, an area of the informal economy that brings hundreds of mechanics and craftspeople into the same market areas, where a new design by one informal entrepreneur is quickly adopted by others, who become the competition.[45]

61. Small and community businesses can be assisted by conventional extension services, which can provide both business and technical advice. National innovation strategies should also include strong champions and programmes for social entrepreneurship, that is, successful businesses that change social structures in positive directions. An example is Sulabh Sanitation,[46] an Indian non-governmental organization with a mission to fight social discrimination. Through its innovative toilet designs and forms of marketing, Sulabh imparted dignity to the jobs of thousands of people, as well as safe, clean toilet facilities to tens of thousands of families.

4. Regulatory policies – setting the ground rules for new technologies

62. Inclusive growth through STI consists not only of science-based regulation, but also high levels of sophistication and significant investments of time, and regulations that integrate employment creation and other public goals with industry promotion. Some technological sectors have greater employment generation potential than others, and innovation policymakers should choose a mix of sectors that generate large employment possibilities across semi-skilled, low-skilled and highly skilled workers.

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[44] CK Prahalad, 2006, *The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits* (Upper Saddle River, New Jersey, Pearson Education, Inc.)

[45] S Daniels, 2010, *Making Do: Innovation in Kenya's Informal Economy* (Analogue Digital).

[46] See http://sulabhinternational.org/, accessed 27 February 2014.

63. Sustainability values need to be woven into aspects of everyday life, such as good public transportation systems, small cars, and re-usable bags for groceries – all good examples of sociotechnical systems that embody values of a society both in terms of technologies and social practices. However, the issues debated in climate change agreements illustrate differences in viewpoints dramatically.[47] From the viewpoint of developing countries, the regulatory expectations that underpin these sociotechnical systems can appear to be threatening. Limiting greenhouse gas emissions sounds like a showstopper for growth. Likewise, prohibitions on genetically modified foods can often be perceived as maintaining trade protection. Regulatory regimes raise costs, then prices, and affect the competitive status of products from the developing world.

64. Dilemmas such as these need to be resolved from the perspective of promoting poverty reduction and development opportunities in developing countries, while being sustainable. This calls for sustainable solutions that are often innovations in themselves; innovations that do not fit with existing sociotechnical systems. Distributed power generation, for example, has the potential to preserve environments, use local skills and knowledge, and spread accessibility of electrical power more quickly and thoroughly than big dam projects.[48] It is thus both inclusive and sustainable.

B. Partners in the effort

65. Various partner institutions join the main STI policy actors in national Governments in their efforts towards inclusive and sustainable development in the post-2015 era, by identifying win–win collaborations that both build STI capacity and link STI policies to development goals. The CSTD should work with the actors described in the following paragraphs to ensure a balanced treatment of STI in the post-2015 developmental agenda.

1. Public institutions

66. Relevant public-sector agencies in developing countries include entities that are beyond the traditional realm of STI, such as health and environment ministries and a range of regulatory bodies. Since it is people that are at the centre of STI capacity, partnerships between STI policy institutions and these other institutions, including educational authorities responsible for higher education, are important.

2. Subnational and supranational policy actors

67. In the post-2015 era, development will depend more on subnational policy actors, such as cities, municipalities, states, or departments, than national ones. These actors will play a critical role in directly relating local-level STI policies to economic development, attracting new companies to the area and nurturing small firms, creating employment and distributing social resources and amenities.

68. For some countries, regional organizations that define collective interests or create shared capabilities at the regional level will be increasingly important in the post-2015 era. African countries, for example, have worked together through the New Partnership for Africa's Development, a technical body of the African Union, to develop STI strategy. Latin America has built some strong regional STI institutions, including its STI indicators network formed in 1994, which has brought together national STI agencies in capacity-

[47] See http://thediplomat.com/2013/11/the-us-and-china-play-chicken-over-climate-change/, accessed 27 February 2014.

[48] See http://unctad.org/en/docs/tir2011_en.pdf, accessed 27 February 2014.

building workshops and conferences and developed a common dataset that compares STI indicators across the continent.[49]

3. International partnerships for development

National development agencies and international non-governmental organizations

69. National STI policy agencies, particularly in least developed countries, may find partnerships in the development agencies of various developed and emerging countries and in international non-governmental organizations. The definition of goals and targets related to STI in the post-2015 agenda will be critical for the success of such partnerships.

International agencies and multilateral development banks

70. International agencies and multilateral development banks have a role to play in bringing STI to bear on inclusive and sustainable development. In general, they have moved beyond a focus on growth alone and have begun to pay attention to distribution, but a focus on STI is currently only restricted to entrepreneurship. There are valuable metrics developed within the United Nations, as published in its annual MDGs report and MDG Gap Task Force Report,[50] and elsewhere. The World Bank publishes a report on World Development Indicators[51] based on officially recognized international sources, which complements the work of the United Nations in this area. The report analyses metrics in relation to each of the eight MDGs which broaden the scope of intervention, including potential areas where STI policies can have an impact.

IV. Findings and suggestions

71. The CSTD, as the torchbearer of STI issues in the United Nations system, has focused on some of the key interfaces between STI and development. This paper has tried to summarize its deliberations and present its role while also looking ahead.

A. Findings

72. Some of the most relevant findings of the report are:

(a) The role of STI as a cross-cutting theme in the post-2015 development agenda needs to be strongly articulated if STI is to contribute to sustainable and inclusive development.

(b) There is a need for new approaches that embed STI policy as an inherent compound of sustainable development in national development plans and give it priority towards this end.

(c) Other ministries, such as health and environment, must take the lead along with STI agencies, to build sustainability into national agendas in developing countries, and a range of regulatory bodies should join the effort.

(d) Most importantly, in the developing country context, STI leaders need to work together with sectoral leaders to build strategic capabilities and give maximum support to the development process.

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[49] See http://www.ricyt.org/homeenglish, accessed 27 February 2014.

[50] See http://www.un.org/millenniumgoals/reports.shtml, accessed 27 February 2014.

[51] See http://databank.worldbank.org/data/download/WDI-2013-ebook.pdf, accessed 27 February 2014.

B. Suggestions

73. The Commission is encouraged to take the following steps:

(a) Help articulate the important role of STI in the post-2015 development agenda by acting as a forum for horizon scanning and strategic planning on ways and means to use STI to tackle future challenges;

(b) Act as a forum where practitioners and experts exchange best practices in using STI for inclusive and sustainable development and help to accumulate lessons learned and improve practice;

(c) Increase communication and cooperation among countries on STI and sustainable development; in this area, STI policymakers are often partners with other government agencies, so a particular focus might be on how to work together on sustainability goals;

(d) Actively contribute to post-2015 discussions on STI and the most effective pathways to design research and innovation policies to achieve poverty reduction.

74. Member States, especially developing countries, are invited to consider the following suggestions:

(a) Promote local innovation capabilities to meet basic needs, and bring together local and scientific knowledge for solving local problems through:

(i) Collaboration between local and national programmes in setting the conditions for indigenous innovation;

(ii) Creating strong, long-term programmes for collaboration between knowledge institutions and marginalized communities to bring together local and scientific knowledge in solving local problems.

(iii) Strengthen collaboration between education institutions to increase enrolment, and to basic skills in mathematics and science.

(b) Encourage local entrepreneurship, eliminating any roadblocks to its operation by considering the following:

(i) Promotion of grassroots innovation and facilitation of commercialization of promising inventions from communities;

(ii) Investment in talented students to enable them to continue their science, technology, engineering, and mathematics education through tertiary education and postgraduate studies, at home or abroad, and provide attractive conditions for their return from abroad;

(iii) Encouraging local innovation as much as possible instead of relying on imports in all sectors of the economy.

(c) Promote the linkages between STI and sustainable development through the following:

(i) Incorporate STI into national developmental planning;

(ii) Encourage sustainability as a general value into public planning and action, including in industry among large and small companies.